Climate change beliefs and savings behavior: a macroeconomic perspective

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The role of beliefs over structural shifts

Key features of expected structural shifts

- fundamental changes, possibly large economic consequences
- unseen and uncertain

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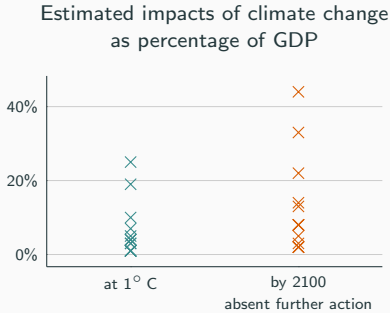
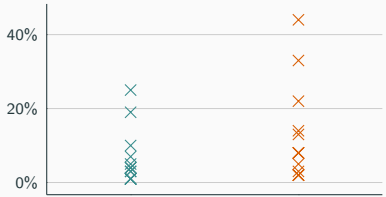
Focus on climate change, but many other examples: rise of AI, fertility decline...

Climate change concerns of experts



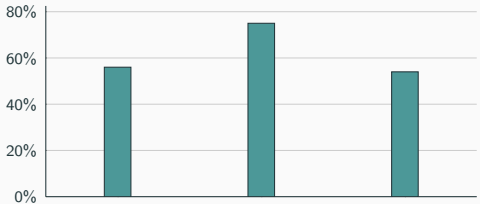
Climate change concerns of experts and population

Estimated impacts of climate change
as percentage of GDP



collected by Aerts et al (2024)
calculations based on leading damage functions

Public opinions on climate change



Shares of respondents.
Data from Pew Research (2022, 19 countries),
Peoples Climate Vote (2024, 50 countries),
ONS (2025, UK)

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What are the macroeconomic implications of climate change beliefs?

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- ➤ fundamental changes, possibly large economic consequences
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- ➤ unseen and uncertain
  $\rightarrow$ belief-based decision making

Focus on climate change, but many other examples: rise of AI, fertility decline...

What are the macroeconomic implications of climate change beliefs?

1. Do beliefs over climate change affect individual savings?
2. Does the effect on capital accumulation have macroeconomic consequences?
   - On aggregate, distributionally?
   - Today, along a transition, permanently?
   - Does disagreement over climate impacts matter?

This paper: individual choices and aggregate effects

Do climate beliefs affect individual savings?

Do climate beliefs matter for macroeconomic outcomes via capital accumulation?

This paper: individual choices and aggregate effects

Do climate beliefs affect individual savings?

- Empirical UK survey evidence: observational (representative panel), causal (online questionnaire)
- Analytical model to rationalize findings

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Do climate beliefs matter for macroeconomic outcomes via capital accumulation?

- Non-stationary general equilibrium model with incomplete markets and aggregate risk
  - Climate change as shift in stochastic productivity process
  - Uncertainty over trend in productivity, but learning from realizations
  - Heterogeneity in income, wealth and beliefs

Key take-aways: climate change beliefs matter.

Climate beliefs increase individual savings both in theory and empirically...

...and affect macroeconomic outcomes during the climate transition.

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- ➢ Significant positive relationship between climate change beliefs and savings choices:
  Likelihood to save +9pp, savings share +1pp, MPS +7.6%
- ➢ Consistent with aggregate productivity impacts from climate change when income effects dominate

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- ➢ Climate concern effect: capital ↑ output loss from climate change ↓
  → NPV of output: +12% under accurate versus too optimistic beliefs
- ➢ Increase in capital benefits the poor disproportionally: wealth inequality ↓
  → Gini: −0.2% during transition relative to initial value
- ➢ Small but persistent impacts of disagreement:
  → NPV of output: +1.5% under homogenous relative to dispersed beliefs

Literature and contributions

Climate change impacts on the macroeconomy

- Stochastic damages: Golosov et al. (2014), Cai and Lontzek (2019)
- Anticipation: Bilal and Rossi-Hansberg (2023), Bakkensen and Barrage (2022)

Contribution: Amplified consequences of climate uncertainty in decentralized framework

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Beliefs and disagreement over aggregate (climate) process

- Hong et al. (2023), Bakkensen et al. (2023), Chen et al. (2012), Lontzek et al. (2024)

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Contribution: Implications along the transition

Incomplete markets and aggregate risks: theory and computation

- Krusell and Smith (1998), Farhi et al. (2022), Broer et al. (2022), Fernández-Villaverde et al. (2023), Bilal (2023), Auclert et al. (2021), Moll (2024)

Contribution: Non-stationarity in aggregate process, global solution method

Overview

Empirical evidence

Analytical Model

Dynamic general equilibrium model

Macroeconomic effects of climate beliefs

Empirical evidence

Empirical support for theoretical predictions

Model predictions:

- Climate change concern increases savings
- Heterogeneity across population

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Test these predictions in the data

- Measure of climate change concern matched with savings choices
- Controls for demographics, in particular income
- Challenge: unobserved characteristics, e.g. preferences

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Two types of UK survey evidence:

1. Observational: large, representative UK panel survey
2. Causal: specific purpose online questionnaire

Observational data

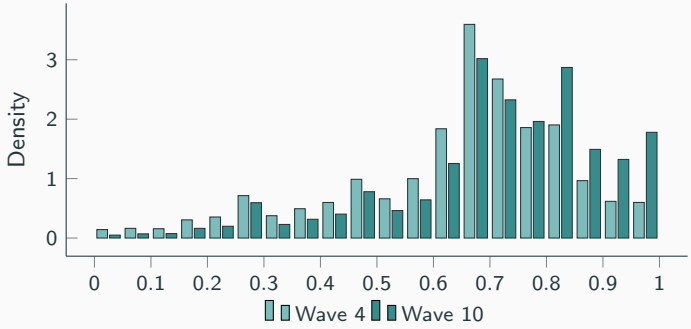
UK Longitudinal Household Survey, waves 4 and 10 (2012-13, 2018-19)

- Construct index about climate change concern

Climate concern index

Five questions on beliefs over climate change, e.g.

- People in the UK will be affected by climate change in the next 30 years.
- If things continue on their current course, we will soon experience a major environmental disaster.



mean $= 0.72$ standard deviation $= 0.22$ autocorrelation $= 0.53$

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- Demographic indicators
  - education, income, age, children, residence, flood exposure (matched)

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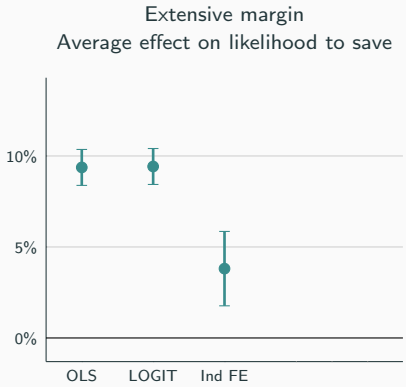
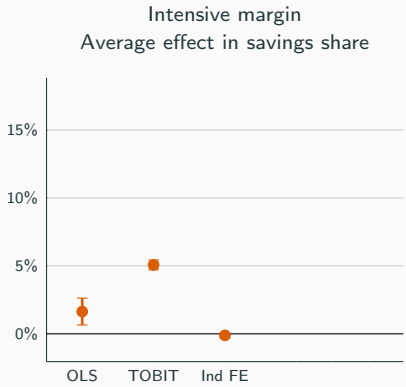
Addresses two main concerns:

1. Preferences over risk and time $\rightarrow$ Individual fixed effects
2. Idiosyncratic exposure $\rightarrow$ Flood exposure, area fixed effects

Empirical results: full versus no concern





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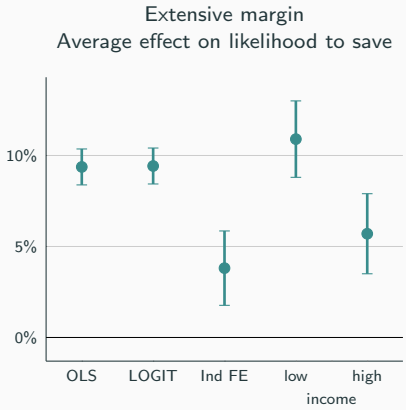

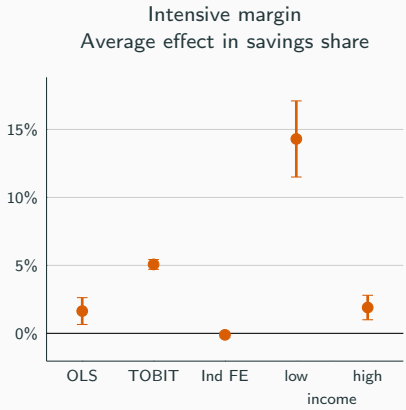

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Goal: obtain causal evidence by using within-subject design (cf. Andre et al., 2025)

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- ➢ Presented in random order

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	Full sample
Δs	7.6%***
Observations	543

	Income		
	low	medium	high
Δs	10.0%***	7.2%**	5.3%
Observations	178	230	81

Survey design | Sample | Questionnaire

Analytical Model

Savings response to a change in climate change beliefs

Consumers allocate resources intertemporally to maximize expected life-time utility, subject to budget constraint and borrowing limit.

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Two types of uncertainty affect income:

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  - ➢ Two possible states: low and high
- Idiosyncratic state: independent of climate change
  - ➢ Demographics: affects labor income

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Model details

How do savings depend on beliefs over climate change?

- ➤ How do intertemporal choices respond to changes in probabilities of aggregate states?
- ➤ First order response to perturbation in probability from Euler equation (cf. Farhi et al., 2022)

First order consumption response

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Take-aways:

1. Concern over adverse macro risks: individual savings $\uparrow$ in standard model
2. Opposing forces of current idiosyncratic state: large effect for poor savers

Take-aways and open questions

Key take-aways:

- Passthrough of adverse aggregate risks: savings $\uparrow$ depending on idiosyncratic state
- Empirical evidence: positive relationship between climate concern and savings choices

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Open question: Do climate change beliefs matter for the macroeconomy?

- How does additional capital accumulation affect output losses during climate transition?
- Does the observed disagreement over climate change matter for macroeconomic outcomes?

→ Dynamic general equilibrium model

Dynamic general equilibrium model

General equilibrium model

Atomic households i

- are subject to exogenous idiosyncratic shocks ϕ_{it} (skills, life-cycle);
- consume c_{it} and save $a_{i,t+1}$ in assets to maximize expected utility given budget $\mathcal{B}$

$$\max_{c_{it}} \ \mathbb{E}_{i0}\left[\sum_{t}^{\infty} \beta^t u(c_{it})\right]$$
$$s.t.\ c_{it} + a_{i,t+1} = \mathcal{B}(\phi_{it}, a_{it}), \quad a_{i,t} \geq 0 \ \ \forall t.$$

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Representative firm

- produces using capital and labor, pays wages and interest according to profit maximization
- is subject to productivity shocks $\zeta_t \in \{\zeta^L, \zeta^H\},\ \zeta^L < \zeta^H$

$$Y_t = \zeta_t K_t^{\alpha} L_t^{1-\alpha} \quad r_t = \alpha Y_t / K_t, \quad w_t = (1-\alpha) Y_t / L_t$$

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Market clearing

$$L_t = \mathcal{L} = \int L(\phi_{it}) di, \quad K_t = \int a_{it} di, \quad Y_t + (1-\delta) K_t = \int \mathcal{B}(\phi_{it}, a_{it}) di$$

Climate change impacts

Climate change

- causes exogenous and deterministic increase in global temperature T_t;
- which is known at time $t = 0$ and may affect the frequency of low productivity states.

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Probability of adverse aggregate shock is given by $\mathbb{P}(\zeta_t = \zeta^L) = p^{1-\gamma T_t}$ with unknown parameter γ

- Two possible states of the world: $\gamma \in \{0, \overline{\gamma}\}$
- Individual initial belief $\pi_{it} = \mathbb{P}_{i0}(\gamma = \overline{\gamma})$
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Impacts modeled via probability, levels stay constant

- Any draw $\{\zeta_t\}_t$ possible under all beliefs
- Implicit level effect

Consumer problem

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Assumption: bounded rationality

Decisions are based on Perceived Law of Motion (PLM)

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How to choose PLM?

1. Find self-justified equilibrium to approximate rational expectations (Krusell and Smith, 1998)
   $\rightarrow$ extend idea to non-stationary framework
2. Alternative: adaptive expectations with varying degree of memory dependence
   $\rightarrow$ addresses critique by Moll (2024)

For period t: Ψ_t distribution of agents over demographics, asset holdings and beliefs.

Dynamic equilibrium

For a given draw $\{\zeta_t\}_t$, initial distribution Ψ_0 and PLM $\mathcal{H}$, the *dynamic equilibrium* of the economy is given by a sequence of distributions $\{\Psi_t\}_{t\geq 0}$ so that:

1. Each period, households and firms optimize given their beliefs; markets clear.
2. Ψ_t evolves according to (i) demographic dynamics, (ii) savings choices, and (iii) Bayes' formula.

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Summary statistics

- Stochastic steady state
- Ensemble averages

Solution algorithm: PLM estimation

Fix some functional form

- ➢ Obvious candidates for $\mathcal{X}$: shock ζ, temperature T, personal belief π
- ➢ Guess for $\mathcal{H}$
  - linear in $\pi \rightarrow$ estimate only for $\pi \in \{0, 1\}$

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Generate simulated data

- ➢ Non-stationarity: ensemble of shock sequences
  - Stratified sample: Match theoretical mean and variance within each period

Iterate on parameters until convergence.

Stratification procedure | Model selection | Adaptive expectations with memory | Model performance | Heterogeneity in forecasts

Calibration

Earnings, life-cycle and preferences:

- AR(1) process for skills estimated on UK panel data
- Expected duration working life (retirement): 40 (20) years; replacement rate 60%
- CRRA utility with $\sigma = 1/IES = 2$, β to match $K/Y = 2.7$ before transition

Aggregate shocks: Effect of climate change on UK productivity

- AR(1) process for temperature, long-run increase of 0.9 deg within 75 years.
- Meta study Rising et al. (2022) estimates output losses:

$$1.1\% \text{ in } 2022,\ 3.3\% \text{ by } 2050,\ 7.4\% \text{ by } 2100$$

- Bad states $p_0 = 0.15$, $\zeta^L = 0.93$:

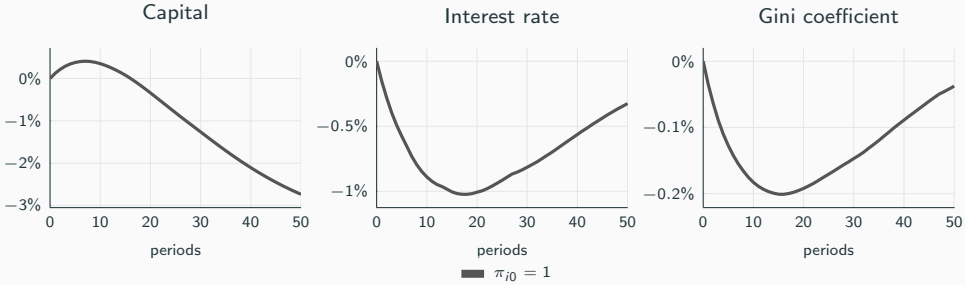
$$\mathbb{E}(\zeta_0) = 0.9895,\ \mathbb{E}(\zeta_{100}) = 0.965$$

Macroeconomic effects of climate beliefs

The climate transition

Baseline: $\overline{\gamma} = \gamma$

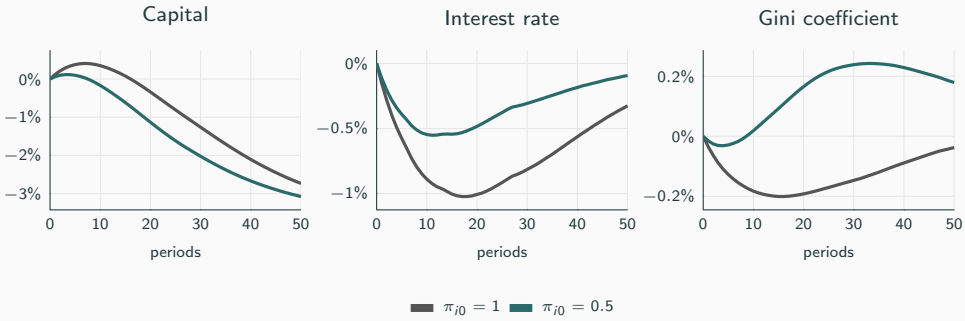
How does the climate transition affect the macroeconomy if everyone expects productivity impacts?



Ensemble averages over time, relative to initial SSS

The role of beliefs during the climate transition

Capital ↓ if population assumes 50% chance of no productivity impacts
→ wealth inequality rises



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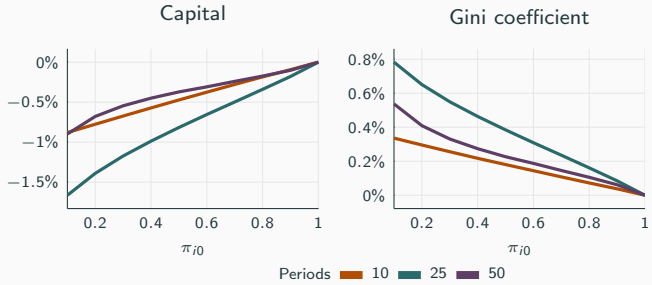
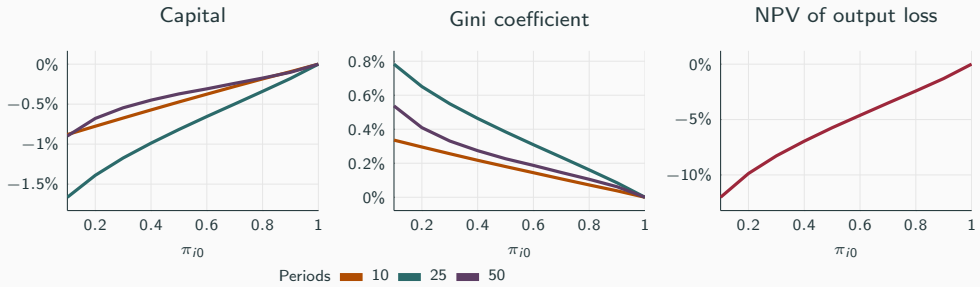


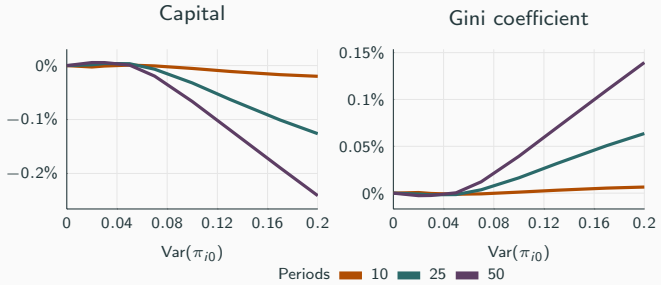
Relative deviation to $\pi_{i0} = 1$, no belief heterogeneity

The role of beliefs during the climate transition



Relative deviation to $\pi_{i0} = 1$, no belief heterogeneity

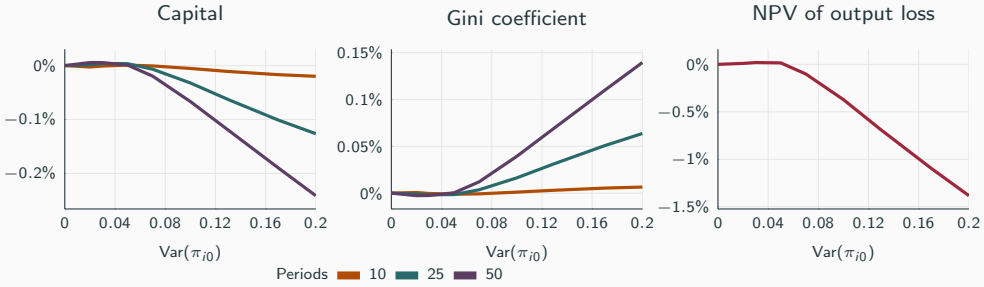
The effects of belief dispersion



Relative deviation to $\text{Var}(\pi_{i0}) = 0$ at $\mathbb{E}(\pi_{i0}) = 0.7$.

- Capital ↓ Gini ↑ under mean-preserving spread
- Persistent: devation rises even after 25 years
- Small effects compared to variation in first moment

The effects of belief dispersion



Relative deviation to $\text{Var}(\pi_{i0}) = 0$ at $\mathbb{E}(\pi_{i0}) = 0.7$.

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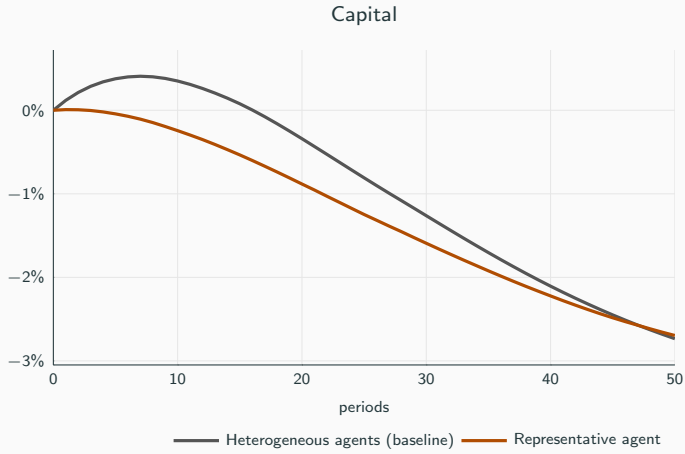
Mechanisms: the role of incomplete markets



Relative deviation to initial SSS

Additional results and robustness

Additional results

- Climate change deniers $\pi_{i0} = 0 \rightarrow$ endogenous polarization
- Alternative true model $\gamma \rightarrow$ asymmetric effects
- Welfare analysis $\rightarrow$ gains for future generations

Robustness

- Alternative PLM: memory matters

Beliefs over climate change matter.

Individual behavior

- Climate concern increases individual savings in model of aggregate climate damages
- Consistent with UK survey evidence

Aggregate and distributional effects

- Climate concern effect: capital increases in short-run, attenuates climate damages
- Heterogeneous impacts: wealth inequality $\downarrow$
- Disagreement: small but persistent role

Beliefs over aggregate risks in incomplete markets

- Development and solution of non-stationary model
- Applicable to range of questions on uncertainty and disagreement over structural shifts

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